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Long-Range Weather Forecasting

By C. E. P. Brooks, D.Sc.

It is a fundamental axiom of economics that demand creates supply, and this seems to be true, not only of material commodities, but also of intangible things of the mind. Mankind has always wanted to know what weather the future had in store, and so from very early times the "public" could always obtain a forecast. Dwellers in the country relied on the behaviour of animals and plants, or on curious atmospheric phenomena, as interpreted in many wise saws and sayings, while their brothers of the town consulted an almanac or an astrologer, and so attained vicarious communion with the stars. The methods may not have been scientific, but there were inevitably a few striking coincidences, and in the absence of any public record of weather to serve as a check, everyone was satisfied. It was not until the middle of the nineteenth century that the first regular official daily forecasts were issued, and replaced the almanac for day-to-day purposes, and it was only with the advent of broadcasting that they penetrated freely into the country.

Forecasts for twenty-four hours ahead are very useful for a variety of purposes, but there is also a demand for information as to the probable weather over a longer period, in the form of "long-range" or "seasonal" forecasts. This demand has been most insistent in agricultural countries such as India, many parts of which are on the borderline of aridity and famine; in that country research in the subject has been carried on for

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some fifty years and reasonably successful seasonal forecasts have been issued regularly throughout the present century. In Egypt the place of long-range weather forecasts is taken by forecasts of the Nile flood. In other countries such as our own the demand has not been so insistent, but of recent years general interest has awakened in the subject, and a great deal of research is being carried out, both by the official meteorological services and by private investigators. The methods in use are very diverse, but, leaving the stars out of account, they may be classified under four headings: Periodicities; Variations of solar activity; Relations between meteorological conditions in different parts of the world, with which we may include ocean temperatures; and Extensions of the method of synoptic forecasting.

As soon as regular meteorological observations became available, meteorologists began to search for periodicities in the hope of finding the golden cycle of weather. As early as 1842 Luke Howard* announced a periodicity of 18 years which he thought would be of use for forecasting. Since then there has been a great deal of research into periodicity, which has helped our insight into the working of the world's weather, but has proved of little use in forecasting. Weather cycles have not the regularity and permanence of astronomical cycles, and when applied to prediction have an annoying habit of breaking down or changing phase. A remarkable example of this occurred in connexion with a series of rainfall forecasts for South Africa published in 1889†, in which the main cycle which had previously remained constant for many years completely reversed its phase in the year following publication, and so made the forecasts worse than useless.

Reasonably successful rainfall forecasts are being made in Java on the basis of a three-year periodicity, but these are controlled by a careful watch on the course of pressure variation and other factors.§

The latest development in the method of forecasting from weather cycles was originated in Italy in 1923 by F. Vercelli,‡ who assumes that in place of true periodicities the pressure distribution and hence the weather is governed by series of waves in the atmosphere which persist for a few weeks and then die away. Hence instead of assuming the existence of various fixed and unalterable periodicities, Vercelli forms a continuous

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* L. Howard. *A cycle of* 18 *years in the seasons of Britain deduced from meteorological observations made at Ackworth in the West Riding of Yorkshire from* 1824 *to* 1841. London, 1842.

† S. E. Hutchins. *Cycles of drought and good seasons in South Africa.* Wynberg, 1899.

‡ F. Vercelli. *Nuovi esperimenti di previsioni meteorologiche.* Roma, 1923.

§ H. P. Berlage, *East Monsoon forecasting in Java.* Batavia, 1927. See *Meteor. Magazine*, 62, 1927, p. 268.

curve from a set of barograms covering about two months, and analyses this curve into its component waves. These waves are then prolonged for a week into the future, and their composition gives the forecasted variations of pressure for that period. The forecasts met with a certain amount of success, and the study of the method is being energetically continued in Europe. Reference may be made to an elaborate paper by L. Weickmann,* in which the technique of the method is fully set out, and several long series of daily weather charts are analysed. The best known practical application of periodicities to long range forecasting in this country is that employed in Lord Dunboyne's forecasts in the *Daily Mail*, which are briefly described in *Nature* for January 29th, 1927. Here it appears that some fifteen cycles are employed, some of which are regarded as permanent and others as evanescent, but full details are not available.

Forecasting from the variations of solar activity is chiefly associated with the name of Mr. H. H. Clayton, who has found various highly complex relations between the occurrence of maxima and minima on the curve of solar radiation obtained at the Smithsonian observatories and the subsequent development of anticyclones and depressions in South America. Weekly forecasts of temperature at Buenos Aires have been issued regularly for some years, but the series of measurements of solar radiation is not yet long enough to solve all the problems of solar relationships. In this country no relationship has yet been demonstrated between solar phenomena and the weather.

The great majority of the successful methods of long-range forecasting at present in use have arisen from the study of the relations between the meteorological conditions in different parts of the world, a branch of investigation chiefly associated with the names of Sir Gilbert Walker, Mr. E. W. Bliss and Professor Exner. The work in India and Egypt, already alluded to, falls into this category, and makes use of antecedent conditions as far away as South America; investigations on similar lines are being carried out in Rhodesia, and altogether it seems probable that in most tropical countries the problem of long-range forecasting depends for its solution on the co-ordination of the succession of the seasons in all parts of the world. Again, the ice conditions in the Barents Sea have been found by W. Wiese to depend on a number of antecedent conditions extending at least as far as the equator, which offer a practical method of forecasting, and studies by Lieut.-Commander E. H. Smith†

* Wellen im Luftmeer. Neuere Untersuchungen über Gesetzmassigkeiten im Gange und in der Verteilung des Luftdruckes. 1 Mitt. *Leipzig, Abh. Sächs. Akad. Wiss.* 39, II., 1924.

† The International Ice Patrol. *London, Meteor Mag.* 60, 1925, p. 229.

suggest a similar possibility for the ice on the Newfoundland Banks. But very little progress has been made as yet in applying this method to long-range forecasts for the British Isles. There appear to be two main reasons for this: first, this method of forecasting is essentially "seasonal," *i.e.*, it is only applicable to countries where the meteorological conditions usually remain sensibly constant for several months; and secondly, the weather of the British Isles is not bound up with the fluctuations of intensity of any one "centre of action," but is influenced in turn by at least three such centres—Iceland, the Azores and Siberia. The importance of the first difficulty is easily seen from a consideration of the weather of the winter of 1927-8, which gave us a dry December, excessively wet weather in January and the first half of February, and another fine spell in the last half of February. The individual characteristics of the months would be largely lost by taking a mean of the conditions over the three. With regard to the second difficulty, a study of the droughts and wet seasons in the British Isles has shown that abnormal seasons depend much less on variations in the intensity of the Icelandic minimum or the Azores high than on displacements of their position. Hence it appears that the real problem for these islands is to forecast such displacements.

Both variations in the intensity of centres of action and displacements of their position show up on charts much more vividly if we plot the deviations from the normal values than if we plot the actual sea-level pressures. It was for this reason that when the Meteorological Office undertook, at the request of the International Meteorological Committee, the preparation and publication year by year of the monthly summary of the meteorological conditions over the globe, which has become widely known under the title of the *Réseau Mondial*, the charts which were drawn to accompany the tables for the years 1910 and 1911 gave, not the actual pressures and temperatures, but the differences from normal values. A considerable series of these charts has now been accumulated and has been subjected to detailed examination. The result is somewhat surprising; it is found that the maps present closed areas in which the pressure is above normal or below normal, which have a close superficial resemblance to the anticyclones or depressions of an ordinary daily weather map, and which also move across the charts from one month to the next in much the same way as anticyclones and depressions, but more slowly, covering only some 700 miles a month instead of about 500 miles a day. It has even been found possible to lay down standard tracks along which the centres tend to move.* An example of a series of such centres moving regularly from west-south-west to east-north-east

* Variations of pressure from month to month in the region of the British Isles. *London, Q. J. R. Meteor. Soc.*, 52, (1926), p. 263.

occurred during the spring and early summer of 1924, and was illustrated in the *Meteorological Magazine* for September of that year.

This discovery seems to open the way for monthly forecasts in general terms of the weather over the British Isles. Before such forecasts can attain a high degree of success, however, a good deal of further research will be necessary. In the first place, the month is too large a unit, but the month is the unit normally adopted in the publication of climatological results, and the labour of repeating the work with a smaller unit would be very great. Secondly, these centres, and especially centres in which the pressure is below normal, often depart from the usual tracks, or die out, and this would falsify the forecasts. To discover the reasons for these irregularities is likely to require a great deal of laborious research, only a small part of which has yet been carried out. Hence, although this method seems at present to offer the best prospect of real long-range forecasts being ultimately practicable in this country, the time is not just yet.

The use of ocean temperatures as indicators of coming weather is at first sight a very promising line of attack. It is well known that the warm water of the Gulf Stream drift exercises a marked effect on the climate of the British Isles, and it seems a logical extension of the argument to assume that variations of the Gulf Stream are of equal importance in causing variations of weather. Actually a slight influence has been traced,* but it represents only a very small fraction of the variability of our weather. The fallacy in the reasoning is that the Gulf Stream is not only an important factor of our climate but it is also an extremely stable factor, and the differences from year to year in the amount of heat which it carries into the North Atlantic are very small compared with the average amount of heat which it brings in any one year. Nevertheless the effect is sufficiently important to make good its claim to be taken into our counsels. In California, where conditions are much less complicated than in western Europe, the temperature of the coastal water has been found by G. F. McEwen to be a useful guide to the probable rainfall.†

The fourth suggested method is the extension of synoptic forecasting from daily weather charts. For a long time now certain stable barometric situations have been recognised as likely to give several days of fine weather in this country, and others as offering no prospect of the cessation of unsettled conditions. With the extension of the area covered by the synoptic charts,

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* The effect of fluctuation of the Gulf Stream on the distribution of pressure over the eastern North Atlantic and western Europe. *London, Meteor. Office, Geophys. Mem.* 4, *No.* 34.

† Forecasting seasonal rainfall from ocean temperatures. *Bull. Amer. Meteor. Soc.*, 5, 1924, p. 137.

and especially with the receipt of wireless messages from ships in the Atlantic, the possibilities in this direction have steadily increased. Unofficial forecasts for a week in advance, based on synoptic charts covering a large area, actually appeared in the *Times* for a considerable period. These weekly forecasts were reasonably successful; from a consideration of the occasional failures it appeared that the cause of failure was the suppression of the detailed sequence of events which would normally result from the situation revealed on a given synoptic chart owing to a change in the more general, more permanent characteristics of the barometric situation. To take a definite example, at the beginning of June, 1925, a depression over the Atlantic was advancing directly towards these islands, and the natural forecast was for a continuance of unsettled weather. The monthly chart for May, however, showed a marked excess of pressure over the Azores which, following the usual track of such centres, would pass directly over Britain. In the conflict of these two tendencies the latter prevailed; the depression over the Atlantic rapidly filled up, and a long spell of fine weather set in, which lasted the whole of the month. This example suggests that the study of the general tendencies of the pressure distribution revealed by the monthly pressure charts may at times assist the forecaster from daily synoptic charts, especially when he is considering the "further outlook," and so lead to the more frequent issue of what may be termed "medium-range" forecasts, perhaps the mose useful form of all for the general public.

Great Storms

From time to time the newspapers startle us with graphic accounts of terrible havoc wrought by great storms of wind, floods, earthquakes and eruptions, but the wave of sympathy soon subsides and the events are forgotten outside the affected area.

In this interesting volume* we are reminded of some of the most notable storms on record and the authors have collected a great deal of authentic information regarding them. Most of the events referred to are connected with the sea and the book is therefore of particular interest to sailors as well as to meteorologists. It was not until 1838 that the important discovery of the "Law of Storms" made it possible for an observer to deduce the approximate position of the storm centre and its track. Previous to this seamen had nothing of the sort to guide them and it is probable that if such information had been available many

* CARR LAUGHTON AND V. HEDDON. *Great Storms.*—Illustrated by Cecil King. 8vo., $8\frac{3}{4} \times 5\frac{1}{2}$ in., pp. vi + 251. London: P. Allan & Co., Ltd., 1927, 10s. 6d. net.

of the stories told of the tragic results of these storms might have been very different.

When Admiral Fitzroy in 1858 began the charting of the weather, he also turned his attention to precautions against destructive storms and a few years later introduced the now well-known "Gale Warnings." Since Fitzroy's days there has been a gradual development in the drawing of weather charts and 220 stations in this country now receive "Gale Warnings."

It is difficult to compare the force of the wind in the storms which occurred before the nineteenth century with that of the storms of more modern days for, as the authors say, "Naturally we could not expect to find a nineteenth century Beaufort Scale of winds with its ascending scale of breezes and gales reaching at its upper limits to a storm and finally to a hurricane in use in the sixteenth century." It is of interest to note however that before the nineteenth century a scale giving designations for winds of different strengths was in use but no numbers were given. The writer of an historical account of the great storm of 1703 referred to in this magazine, points out the contrast of what a ship could stand in his time (1769) and what she could stand in 1703. He says:—"What our sailors call a topsail gale would have driven the navigators of those days into harbour. When our hard gale blows they would have cried a tempest and about the Fret of wind they would been all at their prayers."

With the advance of wireless it has now been made possible for weather information to be received and distributed over large areas and the seaman to-day has a great advantage over his less fortunate brother of earlier days. Under normal conditions the modern seaman need never find himself in the vicinity of a storm centre as did the brig *Chas Heddel*, an account of which is given in the first chapter. This unfortunate ship succeeded in running no less than 5 times round the centre of a storm.

Thrilling episodes are recounted in each chapter of this book. The account of the tragic end of such ships of the Armada as escaped capture is, so far as I am aware, a hitherto unpublished story. The authors follow the fortune of these ships as they grope their way struggling with head winds round the north of Scotland, until each succumbs to her ultimate fate. One ship alone, the flagship, eventually reaches a Spanish port.

In Chapter IV an account of the great storm of 1703 is given. It is said to have destroyed more property and caused the death of more people both on land and sea than any other known English storm. In view of the recent Thames floods it is interesting to find the following remarks in this chapter:—"It is a well-known thing that a strong gale blowing in the direction of the flood tide into a narrowing channel will greatly raise the level of the water at the head of that channel. We have frequent

experience of this in London where a northerly gale at the time of spring tides raises the river to the top of its embankments and even overflows some roads near the waterside."

In the chapters dealing with West Indian Hurricanes and China Typhoons, some interesting accounts are given of the great storms which have occurred in that area. The loss of the S.S. *Antinoe* and H.M. Sloop *Valerian* in 1926 in the North Atlantic is mentioned as a reminder that the wind and sea can still be dangerous to well-found ships with powerful engines. The terrific force of the wind in these storms is emphasised by a description of havoc and devastation wrought by them. In one case a 12-pounder gun is recorded as having been hurled from one battery to another, a distance of 140 yards. It is indeed rare, as the authors say, to meet with a detailed description of what it feels like to be in a typhoon but such interesting details are given in an account of a storm quoted from a letter written by a naval officer who in a destroyer explored, by force of circumstance, the centre of one of these storms.

The tragic facts related in the account of the "Last Voyage of the Elizabeth" in 1764 fill one with admiration for the crew of this old ship. In the last stages of senile decay she made the voyage from Bombay to Spithead. Battered by storms in the Indian Ocean and well-nigh falling to pieces with steering gear gone she eventually arrived at the Cape of Good Hope after a voyage of 85 days. In spite of her terribly bad condition, hogged and frapped together by means of ropes, she continued her voyage and eventually arrived at Spithead where the shipwrights and caulkers, we are told, were surprised beyond expression to see the ship frapped together fore and aft and refused to work on the vessel for fear she would sink at her anchorage. All honour to the brave crew.

Chapter IX recalls the Tay Bridge disaster which occurred in December, 1879, only 7 months after it had been opened. A train was passing over the bridge at the time and out of the 75 passengers not one survived the accident. The authors give an illuminating account of the disaster and the subsequent inquiry.

The story of the complete destruction of St. Pierre by a volcano cloud is graphically told. Tales of heroism always stir the hearts of the British people, and what more gallant story could be told than that of the escape from St. Pierre Harbour of the S.S. *Roddam* on the morning of May 8th, 1902. Eighteen ships were destroyed by fire in the harbour, the *Roddam* alone escaping. "Captain Freeman saw a tremendous cloud of smoke, glowing with live cinders, rushing with terrific rapidity over town and port. He saw the town disappear under the fiery cloud, he saw the ships north of him break into flames, and then the cloud was upon the *Roddam*. . . So she alone

went free with her burnt captain at the wheel steering with his elbows because his hands were too badly burnt to hold the spokes, with her deck hands lying about the deck dead or unconscious and with a hail of hot ashes continuing to fall." The authors justly say, "To stand alone at the helm through long hours, the only man on whom the salvation of the ship depended, implied an endurance and devotion amounting to heroism."

The drawings are excellent, and those who go down to the sea in ships and have experienced such storms as those recounted in the pages of this volume will not say that the roughness of the sea is exaggerated. The book is an ably executed and most attractive and interesting work and is well worth reading.

L. G. GARBETT.

Official Publications

GEOPHYSICAL MEMOIRS—

No. 37. *Studies of Wind and Cloud at Malta.* By J. Wadsworth, M.A. (M.O. 286g)

Malta is a small island, only some 15 miles across, with high ground exceeding 600 feet in the west and a low coastal plain in the east. The two meteorological stations, Pieta and University, are on this coastal plain, the former on a deep bay, the latter near the open sea. The prevailing direction of the surface winds in summer is from the north-west, becoming more northerly in the morning and more westerly in the evening, while the velocity is greatest in the afternoon and least in the early morning. This is interpreted as the usual diurnal variation at an inland station modified by a slight sea-breeze from north-east during the day and a faint katabatic wind during the night from the hills to the west-south-west. The diurnal variation is greater with westerly than with easterly winds. In winter the variation resembles that of summer but is much less regular. Pilot-balloon ascents show that in summer north-westerly winds prevail at all heights, while in winter north-westerly winds preponderate up to 3,000 feet, above which they tend to become westerly. Except near the ground the velocity in summer is generally between 11 and 20 miles per hour, the highest velocities occurring with winds from west.

The cloud observations show that the cloudiest skies occur with easterly winds and the clearest skies with calms and northerly winds. The most frequent type of cloud is cumulus, and the sky tends to clear in the evening, especially with westerly winds.

Corrigendum

March, 1928, p. 52, line 23, *for* "by the Osler swinging plate anemometer" *read* "by the Dines pressure tube anemometer."

Royal Meteorological Society

The monthly meeting of this Society was held on Wednesday, April 18th, at 49, Cromwell Road, South Kensington, Sir Richard Gregory, LL.D., President, in the Chair.

C. K. M. Douglas.—Some Alpine cloud forms.

A number of excellent lantern slides were shown to illustrate the distinction between "banner" clouds, which are turbulent clouds formed as the result of an eddy drawing air up the lee side of a steep mountain in a strong wind, and lenticular caps or "föhn clouds," which are smooth in appearance, and are formed in a damp current crossing the mountain top with vertical displacements which do not seem to be large as a rule, most of the air apparently flowing round the mountain. Banner clouds appear to draw their moisture from lower down than caps, so that the two forms often exist independently though both are produced by strong winds. The existence of caps but no banners may be attributed to a damp layer with dry air below, a condition known frequently to exist.

N. K. Johnson.—A strong wind of small gustiness.

This paper discussed the records of wind velocity and direction obtained at Leafield, Oxon, on two days in December, 1926. On the first of these days the weather was that corresponding to equatorial air, with overcast sky, slight rain and a strong wind. The autographic traces of wind velocity and direction possess considerable width although the mean values of both are nearly constant. The second occasion related to polar air, the sky being practically clear but the wind velocity being approximately equal to that on the first occasion. The records of wind velocity and direction in this case are characterised by the extreme narrowness of the traces, thus indicating a degree of atmospheric turbulence unexpectedly low in view of the strong wind. Whilst polar air normally gives somewhat narrower traces than equatorial, it is shown that the great difference found in the present examples is to be atributed to the difference in the lapse rates obtaining on the two occasions. During the clear night an inversion of nearly 3° F. existed between heights of 1 metre and 87 metres in spite of the wind velocity being 40 miles per hour.

T. N. Hoblyn.—A statistical analysis of the daily observations of the maximum and minimum thermometers at Rothamsted.

Mr. Hoblyn gave an account of the work carried out on 48 years' temperature records at Rothamsted. The labour entailed where so large a mass of data had accumulated was considerable and the method adopted to reduce these data to a more convenient form is given in some detail in a hope that it may be of some value to other stations where records of a similar nature exist. It is pointed out that the interest in temperature in this country lies chiefly in its variation at different periods of the

year not only from day to day but also from year to year. It is shown that at this station both maximum and minimum temperatures do vary significantly from year to year at all periods of the year, although this variation is much greater in some months than in others. The variation of the different measures of temperature is demonstrated by a number of smooth curves.

Correspondence

To the Editor, *The Meteorological Magazine*

Wind in the Mountains

I was interested in the note in your last issue from Seskin, Carrick-on-Suir. I have no doubt that your correspondent is right as to the origin of the noise being in the mountains.

The same phenomenon occurs in the Presteign district of Radnorshire, situate about 6 miles east of the Radnor Forest mountains; the noise is known locally as "The Forest Roaring." The forest is 2,100 feet above sea level and is generally of a smooth wooded formation, and I gather that the noise is only heard in stormy conditions.

R. P. Dansey.

Kentchurch Rectory, Hereford. May 2nd, 1928.

Halo Phenomena

On April 24th at 7.30 a.m. (G.M.T.), there was seen from the station here a brilliant tangent arc to the outer solar halo, although that itself could not be traced. The inner halo was very perfect with a well-developed mock sun on the west. I watched it for some ten minutes before taking my train.

On the afternoon of April 25th a solar halo, at times well developed, was seen here from arrival at about 3.45 (G.M.T.) for over two and a-half hours. A mock sun developed about 5.45 on the east side and became very brilliant, lasting about a quarter of an hour. On both occasions the medium appeared to be a lofty film of cloud, not markedly broken up at the time into cirrus wisps or flocculi. In the evening there was no sign of the outer halo or its tangent arc.

26th, In very similar filmy cloud the tangent arc to the inner halo was bright at 5.45 a.m. (G.M.T.), fading as the halo itself developed later on. The latter was seen here to 7.30 a.m. and then in the City up to 11.30.

27th, At 5.30 a.m. at Purley the inner halo was well formed in the upper quadrant, clouds obscuring lower. At 6.15 it had gone, but the outer halo was formed faintly on the same type of film cloud as on the previous days. Halo seen about 10.30 in the City.

This is the first occasion so far as I can recall, when I have recorded solar halo effects on four successive days. At times on the 28th there were filmy clouds similar in look to those of the 24th-27th, but no sign whatever of halos.

J. EDMUND CLARK.

41, Downscourt Road, Purley, Surrey. April 29th, 1928.

Weather Notes from a Florentine Diary

The following extracts are from the diary kept at Florence by the apothecary Luca Landucci from 1450 to 1516, and continued by another till 1542. The translation used is the recent one by Alice de Rosen Jervis (1927).*

"1490. 10th January. The Arno froze entirely so that 'palla' (tennis) was played upon it and bonfires were made. The cold was great.

17th January. This night there began and continued until the 18th a certain fine rain which froze while it fell and made icicles upon the trees. There was such a quantity of it that the weight bowed the trees down to the ground and broke the branches. Note by the way that this was on the hills. For about half a mile near the river it did no injury. . . . The stacks appeared roofed with glass, and it was too dangerous for anyone to walk in the country.

1493. 20th January. The Day of San Bastiano there was the severest snowstorm in Florence that the oldest people living could remember. Amongst other extraordinary things it was accompanied by such a violent wind that for the whole day it was impossible to open the shops or the doors and windows. . . . All along the street one saw heaps of snow so that in many places neither man nor beasts could pass. In fact these mountains lasted a week. It is difficult to believe without having seen it.

19th May. Our Lady of Santa Maria Impruneta was brought into the city in hopes that the rain might cease and our prayers were granted.

1500. 2nd July. We heard that there had been a hailstorm at Rome in which the hailstones lay two braccia deep with such a violent wind and tempest that the Pope's palace was ruined and part of the room where the Pope (Alexander VI) was sitting fell on the top of him; but as pleased the Lord . . . he was not killed.

1511. 4th September. We heard there had been a terrible hailstorm at Crema in Lombardy with meteoric stones of the weight of 150 pounds each the larger ones and some of the hailstones weighed 30 pounds each, so that roofs were broken and many men and beasts were killed. At the same time great fires were also seen in the air in the evening at the castle of Carpi.

* Published by J. M. Dent and Sons, London.

and then the fire was seen to divide into three parts with loud thunderclaps (Ball lightning?) this being followed with hail and wind that carried away roofs and belfries and did immense damage.

1522. In this year manna fell almost everywhere and it was so hot that the grapes dried on the vines."

There are also numerous allusions to "thunderbolts," notably one on 5th April, 1492, which damaged Santa Maria del Fiore and "was considered a great marvel and significative of some extraordinary event, especcially as it happened suddenly when the weather was calm and the sky without a cloud."

CICELY M. BOTLEY.

17, *Holmesdale Gardens, Hastings. January 24th*, 1928.

NOTES AND QUERIES

A New Wireless Station at South Georgia

Information has been received that the arrangements for the broadcasting of daily weather bulletins from Cumberland Bay, South Georgia, have been completed. This is in accordance with a resolution, passed by the International Meteorological Conference at Utrecht in 1923, that "it is highly desirable in the interest of synoptic meteorology in the southern hemisphere . . . to augment information from the surrounding coasts" of South Africa and South America. This daily meteorological report from Cumberland Bay will be sent by wireless *viâ* Stanley, Falkland Islands, to Monte Video, whence it will be relayed to Rio de Janeiro, the headquarters of the Brazilian Meteorological Service. Here the information will be incorporated on the Brazilian daily weather maps, to which it will form a welcome addition, and here also it will be included in the national and international bulletins broadcast daily from Rio de Janeiro.

The May Cold Spell.

Many attempts have been made to prove or disprove the existence of recurrent cold or warm periods by various treatments of the temperature values, such as the plotting of three-day and five-day means, harmonic analysis, and by the examination of the curves of mean daily temperature. These methods, however, have not resulted in any generally accepted conclusions.

In Europe, perhaps the most celebrated of the interruptions in the annual march of temperature is associated with the festivals of St. Mamertius, St. Pancras and St. Gervais, on May 11th, 12th and 13th, hence called the "Ice Saints," and this particularly has been the subject of considerable investigation. It has

been pointed out in a previous number of the *Meteorological Magazine** that the curve of mean daily temperature does not show a very marked depression around these days. The means of temperature at Kew which accompanied that article showed a slight minimum on May 10th, but the depression amounted to only 0.5°F. These figures referred to the period 1871 to 1900, and it is interesting to notice that the addition of another 27 years has failed to modify this result, a depression of 0.5°F. still leading to a minimum on the 10th. This attributes a surprising amount of constancy to such a minor feature of the curve. If we split up the fifty-seven years 1871 to 1927 into three periods of nineteen years each we have the following means:—

May	7th	8th	9th	10th	11th	12th	13th
1871-1889	50·5	50·6	50·1	*49·7*	49·9	51·4	51·7
1890-1908	51·3	51·6	51·7	51·8	52·4	54·2	53·7
1909-1927	52·6	52·5	52·2	*51·6*	53·2	53·9	53·4

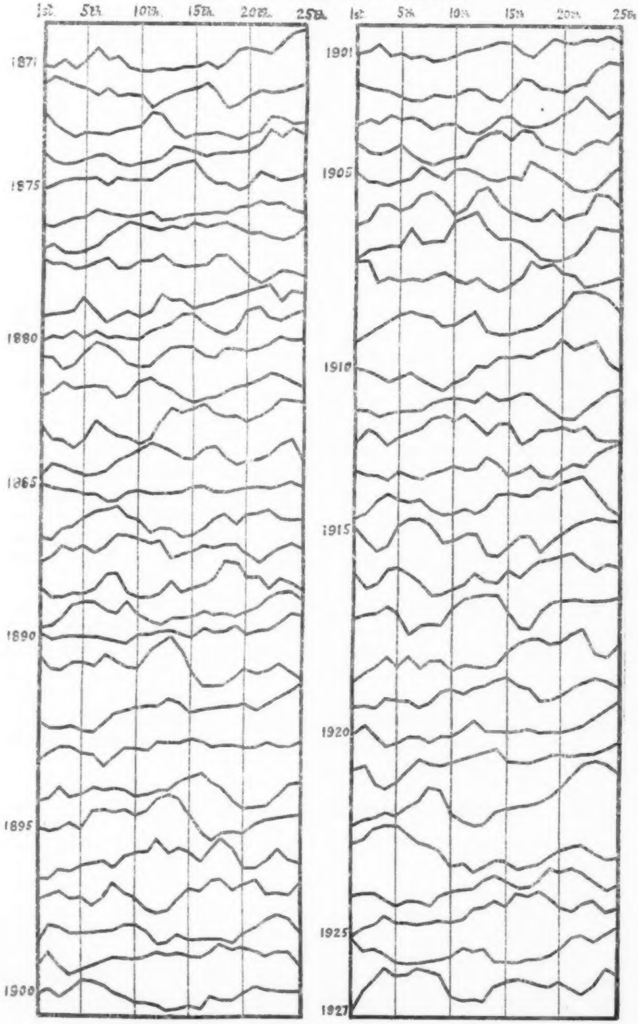
A minimum on the 10th is found in the first and last periods, but not in the middle one. One possible reason for this irregularity is that the cold spell does not recur on exactly the same dates each year, so that by taking averages we smooth it away. According to popular conviction the period lasts about three or four days, and it should reveal itself in the curves of daily mean temperatures for individual years. The accompanying diagram shows the fluctuations of the daily mean temperature at Kew during the period May 1st-25th for the 57 years 1871-1927. The curves are drawn to a scale in which 10°F. = 0.12 in. It will be observed that although in some years—1876 for instance —the temperature rose almost smoothly throughout May, the majority of years show a cold spell during the month which in many cases is very pronounced.

The diagram shows that there is a rather wide range in the time of occurrence—the middle date of the spell may be as early as the 7th and as late as the 22nd, so that the reason why the feature is almost eliminated from the curve of mean daily temperature is obvious. In 1890, one of the years in which the spell does not show definitely in the diagram, a cold period occurred later, centering at the 27th, when the mean temperature was 11.6°F. below that of the 25th. This, however, was very late. Some low temperatures have been experienced at times during the period used in the diagram; in 1877 the minimum on the 5th was as low as 30.0° F.

* Vol. 57, 1922, p. 177.

KEW DAILY MEAN TEMPERATURE

MAY 1st. - 25th. 1871 - 1927.



The frequency with which the lowest daily mean of the period May 5th-20th occurred at Kew on each of those days is shown in the following table :—

Date	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Frequency of occurrence of lowest mean	6	3	7	4	3	4	2	7	3	5	1	1	2	1	3	5
Smoothed values		5	5	4·5	3·5	3	4	5	4·5	3·5	2	1	1·5	2	3	

It is readily calculated that if the distribution were perfectly random the odds against the occurrence of seven minima on any particular day would be 24 to 1; as there are sixteen days in the period the odds in favour of at least one day with seven occurrences are about 2 to 1. Hence the table provides no evidence of any real tendency for a cold spell to occur about May 12th.

In other parts of Europe Ion St. Murat and Gregor Friesenhof have pointed out that other cold periods occur in May, but both agree as to the existence of the Ice Saints' spell—the former giving the date as May 10th-12th for Roumania, and the latter as May 12th-15th for Hungary. It may be considered that two or more cold periods have occurred occasionally at Kew, as in 1872, 1906 and 1917. Buchan in an examination of the temperature records of Scotland, found* that the interruptions which occur in that country include one for the period May 9th-14th.

The bibliography of the subject of abnormalities in the mean daily temperature curve is extensive, and the majority of the publications refer to the cold spell in May. It is interesting to note that the occurrence has been attributed to such diverse causes as the melting of ice in circumpolar latitudes (Fitzroy), the evaporation from newly expanded foliage (Ney), and the cutting off of a certain amount of solar radiation from the earth by meteor showers (Erman).

L. H. Powers.

Bulletin de l'Observatoire de Talence

After an interval of fifteen years the publication of the *Bulletin de l'Observatoire de Talence* (*Gironde*) has been recommenced by M. Henri Mémery, the director of the Talence Observatory, the first number of the new series being issued on January 15th, 1928. The main activities of the Observatory are concerned with the relationship between solar physics and meteorology, and the bulletin is to be devoted to " Etudes des questions relatives à l'action présumée des phénomènes solaires

* Buchan, A. *Handy Book of Meteorology.* 2nd Ed. p. 141.

en météorologie." Thus the aim of the new bulletin is to be the same as that of the old one. The first number contains an article on "Les causes des phénomènes météorologiques sont-elles terrestres ou solaires?," a summary of the sun spots observed at Talence between 1923 and 1927, and an appeal to Observatories which publish daily observations to send these to Talence in order that a daily comparison may be made with the variations of solar phenomena.

The Retirement of Prof. C. Dorno

On April 1st Prof. C. Dorno retired from all active association with the Physical Meteorological Observatory at Davos. Prof. Dorno founded this important observatory in 1907, and from then until October, 1926, he was solely responsible for its work. For the first fifteen years he maintained it at his own private expense, but from 1922 the Swiss Research Institute at Davos has supported it. In October, 1926, Dr. Lindholm, formerly the principal State Meteorologist of Sweden, was released by his Government specially to work with Prof. Dorno in order to get a thorough insight and grasp of the working of the observatory, and now on the retirement of Prof. Dorno he has been appointed the new Director.

During the twenty years of the existence of the Observatory, Prof. Dorno established relations with meteorologists all over the world and maintained close contact with several foreign institutions, especially, in his work on radiation, with the Weather Bureau of the United States, and in his work on "medical meteorology," or, as he afterwards preferred to call it, "physiological meteorology," with Prof. Leonard Hill, of the National Institute of Medical Research at Hampstead, who often quotes Prof. Dorno in *Sunshine and Open Air* and other works.

Among Prof. Dorno's chief papers may be mentioned *Medical Climatology and High Altitude Climate; Klimatologie im Dienste der Medizin; Grundzüge des Klimas von Muottas-Muraigh; Progress in Radiation Measurements.* The holding of the International Climatological Congress at Davos in 1925 was really a personal triumph for Prof. Dorno. We wish him many years of health and happiness in his retirement.

Reviews

Uber die Staubtrübung der Atmosphäre 1909 *bis* 1926. By F. Lindholm. Reprinted from Gerlands Beiträge zur Geophysik, Leipzig 18, 1927, pp. 127-144.

Since 1908 Prof. Dorno has maintained at the Davos Observatory an almost unbroken record of the intensity of solar

radiation, and since 1921 these measurements have been autographic. Taking the monthly means of the measurements on clear days the author has calculated the loss due to scattering in moist dust-free air and that due to selective absorption, and thus arrived at the loss caused by dust and condensation-nuclei. The years 1912 and 1913 were omitted because of the eruption of Katmai. The individual monthly means of this loss are given, with the average diurnal and annual variations. Within the limits of the measurements (sun's altitude 15° or more) there is no appreciable variation of the loss with the height of the sun, but there is a well-marked annual variation with a maximum in March to July. There is a clear correlation between the transparency of the air and the number of rain-days. The author also seeks for a relation with sunspot relative numbers, and finds an indication that the transparency is greatest at sunspot minimum, but the correlation coefficients are scarcely high or systematic enough to amount to proof.

The Climates of the Continents. By W. G. Kendrew, M.A. 2nd edition. Size 9 × 5½, pp. xvi + 400. *Illus.* Oxford. At the Clarendon Press, 1927. £1 1s. net.

For many years meteorologists in this country and in America were reproached with the absence of any adequate handbook of world climatology in the English language. The first volume of J. von Hann's monumental *Handbuch* had been translated into English by Professor R. de C. Ward, who had also written a delightful companion volume entitled *Climate Considered Especially in Relation to Man*, but these works dealt only with the general principles of the science, and hardly at all with the local details. It was a matter almost for tears that the one man who could have vied with Hann in the production of a text-book of climatology, Alexander Buchan, contended himself with a pictorial presentation of the subject, and though Part V of Volume II of the *Report on the Scientific Results of the Voyage of H.M.S. Challenger*, and Volume III of *Bartholomew's Physical Atlas* are unrivalled to this day as climatological atlases, it is not everyone who can read a map. Even prior to 1914 this gap in English meteorological literature was sufficiently notable, but the war, with its widening of all geographical interests and especially the great impetus which it gave to the study of all branches of meteorology, rendered the provision of an English text-book of climatology imperative. That is the genesis of Mr. W. G. Kendrew's *Climates of the Continents*, the first edition of which was published in 1922. The opening sentence in the Preface reads: "This book aims at filling a gap in the sources available for the study of the geography of the Earth." That the book attained its object is shown by the fact that a second edition has now been called for.

The reasons are not far to seek: the exposition is very clear, and is helped by a wealth of illustration (there are no fewer than 153 maps and diagrams) and the arrangement is simple. The Oxford Clarendon Press have also played their part by providing good paper, clearly legible type and a neat binding. The arrangement, as the title suggests, is by continents, the definition of a continent being extended to include New Zealand. One wishes that Mr. Kendrew had chosen a slightly longer title—The Climates of the Continents and Islands—but he must have found sufficiently arduous the collection of the great amount of material which he has already compiled. The collection of data has evidently been made with care, the works of J. von Hann being the chief standby, but in the first edition the author appeared to have missed a number of papers in our own *Quarterly Journal*, including Col. Sir Henry Lyons' important contributions to the climatology of Africa in Vol. XLII, p. 65, and Vol. XLIII, p. 116 and p. 175. In the second edition references to a number of recent papers have been added to the bibliography, but the reviewer cannot find corresponding changes in the text, except that the tale of the continents has now been completed by the addition of a very useful and interesting chapter on Antarctica.

News in Brief

We are informed that Dr. Gorczynski has retired from the Directorship of the Polish Meteorological Institute. He is succeeded by Dr. G. R. Dobrowolski.

Mr. L. S. Woodhead, of Barcombe, near Lewes, reports that on April 27th he saw what appeared to be a small waterspout in the sky at 7.50 p.m. G.M.T. A conical-shaped protuberance appeared from the middle of a cloud and reached about a quarter of the way to earth, when it suddenly broke up and disappeared. The actual time from its first appearance until it broke up was about 10 minutes. The weather was very thundery at the time and a heavy shower had just fallen.

The Weather of April, 1928

The weather of April was variable, with two periods of warm, sunny conditions separated by a cold wintry spell with snow in most places. During the first two or three days the weather was cold and unsettled, with rain at times, but considerable bright intervals; 1·00 in. fell at Ford on the 2nd, and minimum temperatures in the screen were mostly below 30° F. After the 4th the winds backed gradually from NW or W to S, and the air was drawn from the western Mediteranean. There was a gradual

rise in temperature over the whole kingdom, culminating on the 9th and 10th, when the maxima were above 65° F. in many places, and reached 68° F. at Tottenham on the 9th and Greenwich on the 10th. The night of the 9th-10th, too, was exceptionally warm, temperature not falling below 50° F. at several stations, while the minimum, 55° F., at Kew Observatory, constituted a record there for April. During this period bright sunshine was experienced on several days, the 4th, 6th, 8th and 11th being the sunniest; 11·9 hrs. were recorded at Portsmouth on the 8th and at Clacton on the 11th. Thunderstorms occurred locally from the 10th-12th. After the 10th temperature fell decidedly, as the winds backed first to east and then to north. Strong winds and heavy rain in the south on the 14th were associated with a secondary depression over the English Channel, 2·62 in. of rain fell at Glanmire (Cork), 2·52 in. at Roches Point (Cork), and 2·05 in. in the Scilly Isles. By the 15th the rain had turned to sleet and snow, and from then until the 21st snow, sleet and hail showers occurred in all parts of the kingdom. On the 14th, 15th and 16th at some places temperature did not rise above 40° F., and at Lympne the maximum was 37° F. on the 16th. The lowest temperatures for the month were, in the screen, 22° F. at Ford on the 16th, and on the grass, 13° F. at Rhayader on the 17th, 18th and 20th, and at Huddersfield on the 18th. On the 22nd the winds changed to south-west, and the second period of warm weather lasted from then to the end of the month, reaching its highest point on the 26th, when the temperature exceeded 70° F. even as far north as Dumfries, and reached 75° F. at Southport and Cranwell and 74° F. at Kew, Manchester and Hoylake. Strong winds and gales with much rain occurred at times from the 24th to 26th in the west, 1·50 in. being measured at Nenagh (Tipperary) on the 26th. During the last two days the weather became cloudy or overcast generally, with slight rain locally. The 19th, 24th and 28th were the sunniest days in the month, when between 12 and 13·5 hrs. bright sunshine were registered in many parts, *e.g.*, 13·4 hrs. at Margate on the 28th. The total sunshine for the month was below normal in most places, the total of 120 hrs. at Aberdeen being 38 hrs. below normal, that of 155 hrs. at Falmouth being 29 hrs. below normal, while Valentia, Kew and Dublin were 28 hrs., 26 hrs. and 22 hrs. below normal respectively. Stornaway and Birr Castle (King's Co.) had 3 hrs. in excess of the normal.

Pressure was below normal generally over western Europe and the North Atlantic, the greatest deficit being 9·6 mb. at Roches Point. Pressure was above normal over northern Scandinavia, Newfoundland and Bermuda, the greatest excess being 2·9 mb. at Bermuda. Temperature was above normal in northern

Europe, but below normal in Spain. The rainfall distribution was variable. At Spitsbergen the total was 2 in. above normal, in Svealand and western Gothaland only half the normal, and in Kalmar and Gotland above normal.

Snow fell heavily in Switzerland down to 3,000 ft. on the 2nd, interrupting telephone and road communications, and a violent hailstorm occurred in eastern Switzerland on the 11th. Holy week in Spain was so wet that most of the great processions had to be abandoned. There was a cold spell over central Europe on the 17th and 18th. This was accompanied by heavy rain and wind over France, and by snowstorms in Switzerland and Poland. A thunderstorm with heavy rain and hail passed over Paris on the morning of the 29th, and in the evening severe thunderstorms occurred in western Germany doing much material damage.

Four people and 50 cattle were killed as the result of a heavy hailstorm on the 5th in Torsappar Hills, near Peshawar.

Heavy floods throughout the coastal belt of south-eastern Queensland about the 24th caused much damage to the towns in that district.

On the 6th, while New York and the Eastern States were experiencing unseasonably hot weather with a temperature rising towards 80°, heavy snow fell in the Central States interrupting communications in parts of Nebraska and Iowa. Large areas of Arkansas were repeatedly flooded between the 4th and 8th. Floods also occurred in Kansas, Oklahoma and Texas. At the end of the month storms and floods caused the loss of a dozen lives and did considerable damage in the Central and Eastern States. Heavy snow fell in Pennsylvania on the 28th, and also as far south as Maryland, Virginia and North Carolina. Three people were killed in a gale which raged along the New Jersey and Delaware coasts on the 27th and 28th. Serious floods occurred in many parts of Ontario and Quebec about the 9th. The mean temperature for the month was below normal over most of the United States. This cold weather with frequent frosts was very injurious to the crops.

The special message from Brazil states that the rainfall was scarce in the northern and central districts being 2·80 in. and 2·20 in. below normal respectively, but that it was plentiful in the south where the total was 2·64 in. above normal. Seven anticyclones passed across the country and the weather was variable in the south. The cotton, cocoa and coffee crops were generally in good condition. At Rio de Janeiro pressure was 0·5 mb. below normal and temperature 2·3° F. below normal.

Rainfall, April 1928—General Distribution

England and Wales ...	81	per cent. of the average 1881-1915.
Scotland	72	
Ireland	102	
British Isles	83	

Rainfall: April, 1928: England and Wales

Co.	Station	In.	Per-cent. of Av.	Co.	Station	In.	Per-cent. of Av.
Lond .	Camden Square	1·32	86	*Leics* .	Thornton Reservoir ...	1·36	80
Sur .	Reigate, The Knowle...	1·82	117	,, .	Belvoir Castle	·58	38
Kent .	Tenterden, Ashenden...	2·73	169	*Rut* .	Ridlington	·91	...
,, .	Folkestone, Boro. San.	3·18	...	*Linc* .	Boston, Skirbeck	1·15	85
,, .	Margate, Cliftonville...	1·57	116	,, .	Lincoln, Sessions House	·67	48
,, .	Sevenoaks, Speldhurst	2·15	...	,, .	Skegness, Marine Gdns	1·13	84
Sus .	Patching Farm	2·76	158	,, .	Louth, Westgate	1·26	75
,, .	Brighton, Old Steyne	3·77	233	,, .	Brigg, Wrawby St. ...	1·00	...
,, .	Tottingworth Park ...	2·73	148	*Notts* .	Worksop, Hodsock ...	·79	54
Hants .	Ventnor, Roy. Nat. Hos.	2·33	139	*Derby* .	Derby	1·19	73
,, .	Fordingbridge, Oaklnds	1·81	99	,, .	Buxton, Devon Hos.	1·34	46
,, .	Ovington Rectory	2·04	108	*Ches* .	Runcorn, Western Pt.	·84	49
,, .	Sherborne St. John ...	1·72	97	,, .	Nantwich, Dorfold Hall	1·51	...
Berks .	Wellington College ...	1·54	96	*Lancs* .	Manchester, Whit. Pk.	·85	44
,, .	Newbury, Greenham...	2·01	110	,, .	Stonyhurst College ...	1·33	49
Herts .	Benington House	1·35	88	,, .	Southport, Hesketh Pk	1·39	75
Bucks .	High Wycombe	1·50	96	,, .	Lancaster, Strathspey	1·64	...
Oxf . .	Oxford, Mag. College	·98	64	*Yorks* .	Wath-upon-Dearne ...	·94	60
Nor .	Pitsford, Sedgebrook...	1·97	129	,, .	Bradford, Lister Pk.	1·05	52
,, .	Oundle	·94	...	,, .	Oughtershaw Hall	1·68	...
Beds .	Woburn, Crawley Mill	1·11	74	,, .	Wetherby, Ribston H.	·78	44
Cam .	Cambridge, Bot. Gdns.	·65	48	,, .	Hull, Pearson Park ...	·92	59
Essex .	Chelmsford, County Lab	·81	63	,, .	Holme-on-Spalding ...	1·02	...
,, .	Lexden, Hill House ...	·92	...	,, .	West Witton, Ivy Ho.	·71	...
Suff .	Hawkedon Rectory ...	1·48	96	,, .	Felixkirk, Mt. St. John	·90	54
,, .	Haughley House	1·05	...	,, .	Pickering, Hungate ...	1·22	...
Norf .	Beccles, Geldeston	1·23	84	,, .	Scarborough	1·78	114
,, .	Norwich, Eaton	1·50	88	,, .	Middlesbrough	·78	57
,, .	Blakeney	1·49	116	,, .	Baldersdale, Hury Res.	·94	...
,, .	Little Dunham	...	...	*Durh* .	Ushaw College	·71	40
Wilts .	Devizes, Highclere	1·15	61	*Nor* .	Newcastle, Town Moor	·93	57
,, .	Bishops Cannings	1·75	87	,, .	Bellingham, Highgreen	·93	...
Dor .	Evershot, Melbury Ho.	1·88	80	,, .	Lilburn Tower Gdns.	1·43	...
,, .	Creech Grange	1·93	...	*Cumb* .	Geltsdale	·60	...
,, .	Shaftesbury, Abbey Ho.	1·43	67	,, .	Carlisle, Scaleby Hall	·95	49
Devon .	Plymouth, The Hoe ..	1·46	64	,, .	Borrowdale, Rosthwaite	4·69	...
,, .	Polapit Tamar	2·21	94	,, .	Keswick, High Hill ...	1·65	...
,, .	Ashburton, Druid Ho.	3·41	112	*Glam* .	Cardiff, Ely P. Stn. ...	1·53	61
,, .	Cullompton	1·28	56	,, .	Treherbert, Tynywaun	2·60	...
,, .	Sidmouth, Sidmount...	1·49	70	*Carm* .	Carmarthen Friary ...	1·67	61
,, .	Filleigh, Castle Hill ...	1·74	...	,, .	Llanwrda, Dolaucothy	2·30	70
,, .	Barnstaple N. Dev. Ath.	1·63	77	*Pemb* .	Haverfordwest, School	1·43	55
Corn .	Redruth, Trewirgie ...	3·23	112	*Card* .	Gogerddan	...	...
,, .	Penzance, Morrab Gdn.	2·57	106	,, .	Cardigan, County Sch.	1·01	...
,, .	St. Austell, Trevarna...	2·18	77	*Brec* .	Crickhowell, Talymaes	1·40	...
Soms .	Chewton Mendip	1·88	63	*Rad* .	Birm W. W. Tyrmynydd	2·44	66
,, .	Street, Hind Hayes ...	...	...	*Mont* .	Lake Vyrnwy	2·67	89
Glos. .	Clifton College	...	...	*Denb* .	Llangynhafal	1·22	...
,, .	Cirencester, Gwynfa ...	1·44	77	*Mer* .	Dolgelly, Bryntirion...	2·96	81
Here .	Ross, Birchlea	1·08	57	*Carn* .	Llandudno	·85	47
,, .	Ledbury, Underdown	1·23	68	,, .	Snowdon, L. Llydaw 9	5·21	...
Salop .	Church Stretton	1·92	89	*Ang* .	Holyhead, Salt Island	·80	38
,, .	Shifnal, Hatton Grange	1·40	83	,, .	Lligwy	·83	...
Worc .	Ombersley, Holt Lock	1.18	78	*Isle of Man*			
,, .	Blockley, Upton Wold	1·03	53		Douglas, Boro' Cem.	1·66	68
War .	Farnborough	1·65	84	*Guernsey*			
,, .	Birminghm, Edgbaston	1·48	85		St. Peter P't. Grange Rd.	2·85	142

Erratum for March, Cambridge for 136 read 74 per cent.

Rainfall: April, 1928: Scotland and Ireland

Co.	Station	In.	Per-cent of Av.	Co.	Station	In.	Per-cent. of Av.
Wigt	Stoneykirk, Ardwell Ho	2·38	113	*Suth*	Loch More, Achfary	3·00	62
,,	Pt. William, Monreith	1·85	...	*Caith*	Wick	1·60	80
Kirk	Carsphairn, Shiel.	2·89	...	*Ork*	Pomona, Deerness	1·61	78
,,	Dumfries, Cargen	1·91	72	*Shet*	Lerwick	1·58	69
Dumf.	Eskdalemuir Obs.	1·78	52	*Cork*	Caheragh Rectory	5·02	...
Roxb	Branxholm	1·08	57	,,	Dunmanway Rectory	5·82	140
Selk	Ettrick Manse	1·57	..	,,	Ballinacurra	6·05	234
Peeb	West Linton	1·03	...	,,	Glanmire, Lota Lo.	5·85	209
Berk	Marchmont House	1·45	72	*Kerry*	Valentia Obsy.	5·00	136
Hadd	North Berwick Res.	·64	46	,,	Gearahameen	8·90	...
Midl	Edinburgh, Roy. Obs.	·56	41	,,	Killarney Asylum	5·16	156
Ayr	Kilmarnock, Agric. C.	1·28	62	,,	Darrynane Abbey	4·89	142
,,	Girvan, Pinmore	2·09	70	*Wat*	Waterford, Brook Lo...	2·74	108
Renf	Glasgow, Queen's Pk.	1·06	54	*Tip*	Nenagh, Cas. Lough...	2·71	108
,,	Greenock, Prospect H.	3·46	95	,,	Roscrea, Timoney Park	1·70	...
Bute	Rothesay, Ardencraig.	2·63	88	,,	Cashel, Ballinamona...	2·85	114
,,	Dougarie Lodge	2·36	...	*Lim*	Foynes, Coolnanes	3.77	154
Arg	Ardgour House	4·86	...	,,	Castleconnel Rec.	2·71	...
,,	Manse of Glenorchy	3·74	...	*Clare*	Inagh, Mount Callan...	4·90	...
,,	Oban	2·95	...	,,	Broadford, Hurdlest'n.	2·85	...
,,	Poltalloch	3·32	110	*Wexf.*	Newtownbarry	2·90	...
,,	Inveraray Castle	3·44	75	,,	Gorey, Courtown Ho	2·44	111
,,	Islay, Eallabus	2·62	91	*Kilk*	Kilkenny Castle	2·11	97
,,	Mull, Benmore	8·70	...	*Wic*	Rathnew, Clonmannon	2·00	...
,,	Tiree	2·15	...	*Carl*	Hacketstown Rectory	3·08	116
Kinr	Loch Leven Sluice	·78	41	*QCo*	Blandsfort House	2·03	78
Perth	Loch Dhu	5·15	109	,,	Mountmellick	1·94	...
,,	Balquhidder, Stronvar	2·82	...	*KCo*	Birr Castle	1·84	86
,,	Crieff, Strathearn Hyd.	1·58	72	*Dubl*	Dublin, FitzWm. Sq...	1·25	66
,,	Blair Castle Gardens	·85	40	,,	Balbriggan, Ardgillan.	1·39	70
Forf	Kettins School	1·18	71	*Me'th*	Beaupare, St. Cloud...	1·33	...
,,	Dundee, E. Necropolis	1·01	59	,,	Kells, Headfort	1·70	68
,,	Pearsie House	1·43	...	*W.M*	Moate, Coolatore	1·55	...
,,	Montrose, Sunnyside...	...	...	,,	Mullingar, Belvedere..	1·41	59
Aber	Braemar, Bank	·59	25	*Long*	Castle Forbes Gdns	1·54	64
,,	Logie Coldstone Sch.	1·23	61	*Gal*	Ballynahinch Castle...	4·23	119
,,	Aberdeen, King's Coll.	2·57	137	,,	Galway, Grammar Sch.	2·36	...
,,	Fyvie Castle	2·47	...	*Mayo*	Mallaranny	3·01	...
Mor	Gordon Castle	·81	46	,,	Westport House	2·75	102
,,	Grantown-on-Spey	1·20	61	,,	Delphi Lodge	5·75	...
Na	Nairn, Delnies	·88	59	*Sligo*	Markree Obsy	1·78	67
Inv	Ben Alder Lodge	...	...	*Cav'n*	Belturbet, Cloverhill...	2·11	92
,,	Kingussie, The Birches	1·07	...	*Ferm*	Enniskillen, Portora...	2·47	...
,,	Loch Quoich, Loan	5·20	...	*Arm*	Armagh Obsy	1·78	85
,,	Glenquoich	5·35	82	*Down*	Fofanny Reservoir	5·21	...
,,	Inverness, Culduthel R.	·96	...	,,	Seaforde	2·25	86
,,	Arisaig, Faire-na-Squir	...	...	,,	Donaghadee, C. Stn...	1·96	98
,,	Fort William	4·19	94	,,	Banbridge, Milltown...	1·05	51
,,	Skye, Dunvegan	3·21	...	*Antr*	Belfast, Cavehill Rd...	1·67	...
R & C.	Alness, Ardross Cas.	1·64	68	,,	Glenarm Castle	2·27	...
,,	Ullapool	2·12	...	,,	Ballymena, Harryville	2·31	87
,,	Torridon, Bendamph...	4·61	88	*Lon*	Londonderry, Creggan	1.71	67
,,	Achnashellach	3·46	...	*Tyr*	Donaghmore	1·85	...
,,	Stornoway	2·44	81	,,	Omagh, Edenfel	2·27	86
Suth	Lairg	1·30	...	*Don*	Malin Head	1·32	67
,,	Tongue	1·81	69	,,	Dunfanaghy	2·25	...
,,	Melvich	1·38	59	,,	Killybegs, Rockmount.	1·39	39

Climatological Table for the British Empire, November, 1927

STATIONS	PRESSURE: Mean of Day M.S.L. (mb.)	PRESSURE: Diff. from Normal (mb.)	TEMPERATURE Absolute: Max. (° F.)	TEMPERATURE Absolute: Min. (° F)	TEMPERATURE Mean Values: Max. (° F.)	TEMPERATURE Mean Values: Min. (° F.)	TEMPERATURE Mean Values: ½ max. and min. (° F.)	TEMPERATURE Mean Values: Diff. from Normal (° F.)	TEMPERATURE Mean: Wet Bulb (° F.)	Relative Humidity (%)	Mean Cloud Am'nt (0—10)	PRECIPITATION: Am'nt (in.)	PRECIPITATION: Diff. from Normal (in.)	PRECIPITATION: Days	BRIGHT SUNSHINE: Hours per day	BRIGHT SUNSHINE: Percentage of possible
London, Kew Obsy.	1014·8	+ 0·2	62	28	48·4	39·0	43·7	− 0·3	40·1	91	7·8	2·69	+ 0·47	13	1·4	16
Gibraltar	1015·5	− 2·5	75	43	65·5	53·5	59·5	− 1·0	52·9	81	5·7	6·52	+ 0·13	9	..	..
Malta	1018·2	+ 1·7	75	53	69·5	62·3	65·9	+ 2·0	62·9	88	5·8	3·31	− 0·26	8	6·1	60
St. Helena	1013·1	+ 1·8	66	55	63·6	56·0	59·8	− 0·3	56·6	94	9·5	0·60	− 1·08	8	..	..
Sierra Leone	1011·2	+ 0·3	90	70	86·9	73·4	80·1	− 1·1	76·5	82	6·4	4·48	− 0·64	12	..	..
Lagos, Nigeria	1009·9	− 0·9	91	72	88·1	76·8	82·5	+ 1·1	77·7	82	5·2	2·38	− 0·20	5	..	..
Kaduna, Nigeria	1014·5	+ 3·2	94	60	90·6	67·6	79·1	+ 2·9	69·2	62	1·0	0·00	− 0·12	0	..	..
Zomba, Nyasaland	1009·7	+ 0·8	94	53	87·7	63·3	75·5	− 0·1	..	80	6·1	2·02	− 3·06	8	..	..
Salisbury, Rhodesia	1010·8	+ 0·4	91	48	80·7	57·6	69·1	− 1·6	61·8	59	4·9	3·71	+ 0·01	12	8·0	62
Cape Town	1014·8	− 1·0	101	48	77·6	58·4	68·0	+ 3·6	60·7	72	4·7	1·52	+ 0·44	7	..	..
Johannesburg	1012·9	+ 1·3	87	44	78·6	54·1	66·3	+ 2·8	56·1	57	2·2	1·85	− 3·11	7	9·4	71
Mauritius	1016·3	+ 0·2	88	64	81·9	68·4	75·1	− 0·4	70·5	65	5·9	0·74	− 0·84	15	8·3	64
Bloemfontein	..	..	94	40	84·5	56·2	70·3	+ 1·9	58·5	55	4·0	0·93	− 1·34	2	..	..
Calcutta, Alipore Obsy.	1013·8	+ 0·5	90	58	83·9	65·2	74·5	+ 1·4	65·7	82	1·3	0·23	− 0·43	1*	..	..
Bombay	1011·5	− 0·5	92	65	84·3	72·0	78·1	− 2·4	68·5	76	2·6	5·48	+ 5·03	3*	..	..
Madras	1011·5	+ 0·2	88	62	84·5	72·2	78·3	− 0·6	72·4	79	6·1	15·22	+ 0·97	13*	..	..
Colombo, Ceylon	1011·1	+ 1·0	89	71	86·4	73·8	80·1	+ 0·4	75·9	75	7·1	7·43	− 4·36	15	6·3	53
Hongkong	1016·7	− 0·9	82	59	75·9	67·1	71·5	+ 1·9	63·8	63	3·6	1·83	+ 0·16	6	7·7	70
Sandakan	..	..	90	73	88·2	74·9	81·5	+ 0·7	77·4	87	..	15·65	+ 0·99	19	..	..
Sydney	1015·3	+ 1·6	83	53	72·0	59·9	65·9	− 1·2	62·2	70	6·4	6·06	+ 3·25	11	6·6	47
Melbourne	1015·5	+ 1·3	102	46	75·2	54·3	64·7	+ 3·4	57·6	55	5·6	1·19	− 1·03	8	7·5	54
Adelaide	1015·6	+ 0·5	103	48	82·9	57·3	70·1	+ 3·2	58·1	35	5·0	1·47	+ 0·31	4	9·8	71
Perth, W. Australia	1015·9	+ 0·6	94	49	77·0	57·3	67·1	+ 1·1	60·3	55	4·1	0·43	− 0·36	6	10·3	75
Coolgardie	1013·7	+ 0·6	105	43	88·3	57·5	72·9	+ 2·1	60·0	47	2·6	0·18	− 0·50	3	..	..
Brisbane	1014·7	+ 0·2	87	59	80·6	64·9	72·7	− 0·9	66·9	67	6·5	5·82	+ 2·16	15	7·8	58
Hobart, Tasmania	1014·4	+ 5·0	84	40	66·6	48·0	57·3	+ 0·1	51·1	55	6·6	1·31	− 1·21	14	8·5	59
Wellington, N.Z.	1011·6	− 0·5	66	38	61·1	48·7	54·9	− 2·0	51·7	71	7·0	5·72	+ 2·20	19	5·1	35
Suva, Fiji	1009·6	− 1·5	88	68	83·5	73·1	78·3	+ 1·1	74·4	81	7·2	15·38	+ 5·87	29	4·9	38
Apia, Samoa	1008·4	− 1·1	89	74	85·5	75·5	80·5	+ 1·8	78·0	78	5·8	13·22	+ 3·93	20	6·1	48
Kingston, Jamaica	1011·7	− 0·7	91	69	86·5	71·6	79·1	− 0·2	70·6	89	5·6	2·85	− 0·18	5	7·3	65
Grenada, W.I.	1006·8	− 3·5	91	73	86·3	75·7	81·0	+ 1·7	76·7	78	4·8	12·25	+ 3·86	17	..	..
Toronto	1017·0	+ 0·2	69	22	47·7	34·2	40·9	+ 4·6	38·1	85	8·8	4·37	+ 1·42	22	2·1	22
Winnipeg	1019·2	+ 2·5	48	−10	23·0	11·5	17·3	− 3·5	...	...	7·0	0·95	− 0·01	9	3·5	38
St. John, N.B.	1017·6	+ 3·7	63	19	45·9	33·4	39·7	+ 3·0	36·8	79	6·4	4·07	− 0·34	15	2·6	27
Victoria, B.C.	1014·1	− 1·4	58	35	47·7	40·5	44·1	− 0·3	42·2	86	8·4	5·98	− 0·48	26	2·0	22

* For Indian stations a rain day is a day on which 0·1 in. or more rain has fallen.

St. John, N.B.	1017·6	+ 3·7	63	19	45·9	33·4	39·7	+ 3·0	36·8	79	6·4	4·07	−	0·34	9	3·5	38
Victoria, B.C.	1014·1	− 1·4	58	35	47·7	40·5	44·1	− 0·3	42·2	86	8·4	5·98	−	0·48	26	2·0	22

* For Indian stations a rain day is a day on which 0·1 in. or more rain has fallen.